VOL. IV. OCTOBER, 1906 NOS. 67-68

MYCOLOGICAL BULLETIN

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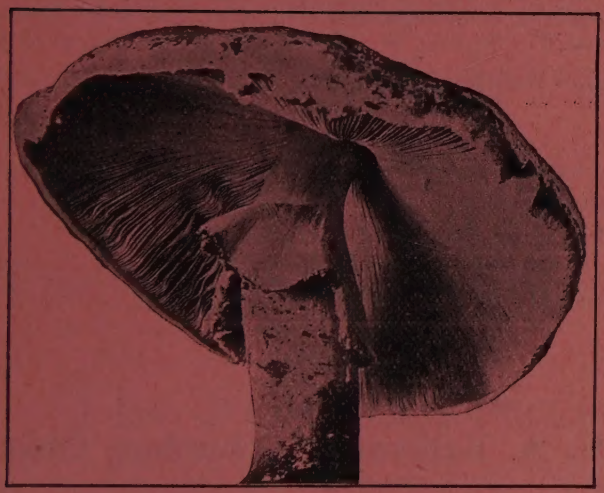

ENTERED AS SECOND CLASS MATTER MAY 11, 1906, AT THE POSTOFFICE AT COLUMBUS, OHIO.

Edited and Published by
W. A. KELLERMAN

Press of VANCE-POLAND CO.
Columbus, Ohio

Mycological Bulletin

Nos. 67-68

W. A. Kellerman, Ph. D., Ohio State University
Columbus, October, 1906.

A REAL MUSHROOM NUMBER.

Through the kindness of Albert F. Woods, the Pathologist and Physiologist of the U. S. Department of Agriculture, it is possible to use in this NUMBER, cuts published in Bulletin No. 85, of the Bureau of Plant Industry on *The Principles of Mushroom Growing and Mushroom Spawn Making,* by B. M. Duggar, and to make extensive quotations from that interesting and important work. The Bulletin may be obtained from the U. S. Department of Agriculture and all interested especially in Mushroom growing, are urged to send for a copy.

Dr. Duggar treats his subject under the following heads: Introduction, General Considerations, Market Conditions, Germination Studies, Review of Earlier Work, Experimental Work, Tissue Cultures, Nutrition, Growth on Manure and Other Complex Media, Growth on Chemically Known Media, Tabulation of Special Results, Acid and Alkaline Media, Temperature and Moisture, Preparation of the Compost, Installation of Beds, Spawning and Casing the Beds, Mushroom Growing, Experiments at Columbia, Mo., Variability in Mushrooms Grown Under Different Conditions, The Cultivation of Various Species of Mushrooms, Co-operative Experiments, Cave Facilities in the United States, Open-air-culture, Mushroom Spawn Making, A "Chance" Method, A "Selective" Method, Pure-culture Precautions, The Tissue-culture Method, The Commercial Process and The Vitality of Mushroom Spawn. Quotations as far as space allows follow:

QUOTATIONS FROM DUGGAR'S BULLETIN ON THE PRINCIPLES OF MUSHROOM GROWING AND MUSHROOM SPAWN MAKING:

The conditions under which mushrooms may be successfully grown are limited, and intelligent attention is therefore essential. It must be said, moreover, that the majority of failures may be directly traced to erroneous ideas as to the cultural requisites, or to a reckless disregard of conditions. The essential conditions will be subsequently defined in detail, but it may be stated here that failures are usually due to one or more of the following causes: (1) Poor spawn; (2) very poor manure; (3) unfavorable temperature; and (4) heavy watering during the early stages of growth.

Under suitable conditions mushrooms may be grown with assurance of

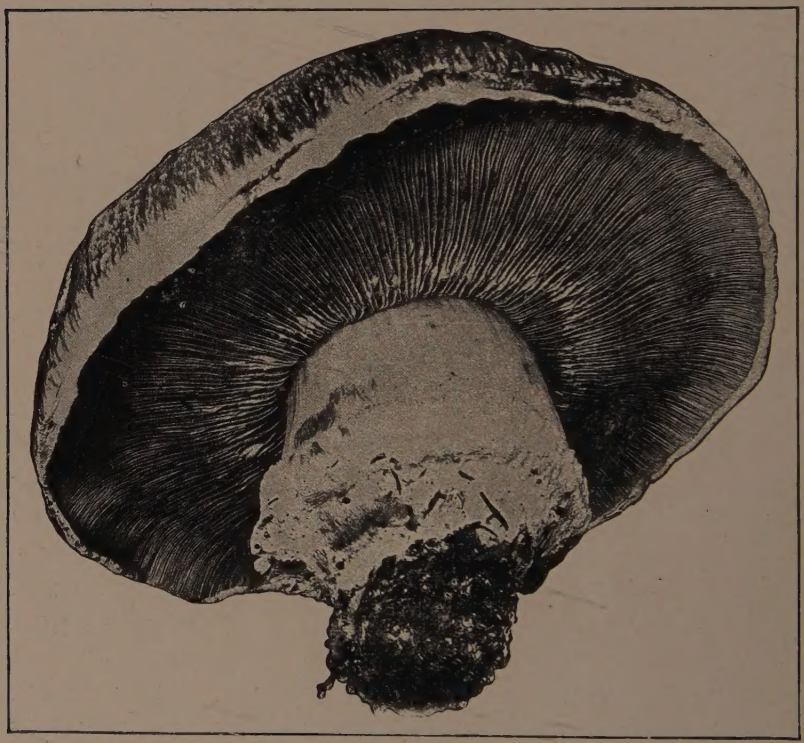

Fig. 205. AGARICUS VILLATICUS. A promising species, fleshy and prolific. From Bulletin No. 85, B. M. Duggar, Bureau of Plant Industry, U. S. Department of Agriculture.

success. Ordinarily they are grown only where the conditions may be controlled, and success should therefore be invariable.

In many cases it has been possible to obtain growth from the spores by the use of the stimulating salts which have been mentioned in connection with the germination studies. Where it is desired to make experiments along this line the writer has found it more practicable to

use spores from a mushroom as young as possible. If one takes a mushroom just at the time that the veil is breaking, inoculations may be readily made from the spores and few contaminations will result. In this case, by means of a sterile needle, or scalpel, a few spores may be removed from the spore-bearing, or gill, surface and these may be transferred to the tubes in the same way as were bits of the fresh tissue. It is also possible to secure a spore print from a mushroom the gill surface of which has not been exposed to germs of the atmosphere. In the latter case it is desirable to remove stem and partial veil, peel off the incurved edges of the cap which have been in contact with the soil, and place the cap, gill surface downward, in a sterilized dish or on sterile paper. If this is then kept free from dust, a spore print may be obtained, which should not be contaminated by foreign germs. This print may then be used in making a large number of spore cultures.

Tissue Cultures.—The suggestion which had presented itself of using bits of living tissue from a sporophore instead of spores seemed also, from general observations, to be of sufficient importance to warrant a thorough trial. During moist weather, or in a moist cellar where

Fig. 206. A fine cluster of Agaricus campestris, the Horticultural Variety Columbia. From Bulletin No. 85, B. M. Duggar, Bureau of Plant Industry, U. S. Department of Agriculture.

mushrooms are being grown, one will frequently find that an injury in a young mushroom is rapidly healed by a growth of hyphae from the edges of the injured area. The same thing had been noted in the open in the case of puffballs. In many instances, moreover, pure cultures of fungi in other groups have been obtained by the use of small bits of a sclerotial mass of tissue. Accordingly, a young sporophore of *Agaricus campestris* was obtained, and after breaking it open longitudinally a number of pieces of tissue from within were carefully removed with a sterile scalpel to a sterile Petri dish. A number of cultures were then made by this tissue-culture method on a variety of nutrient media, such as bean pods, manure, leaf mold, etc. From this and from numerous other similar tests it was ascertained that when the mushrooms, from which the nodules of tissue are taken, are young and healthy, there is seldom an instance in which growth does not result. It was easily shown that failure to grow was generally due to the advanced age of the mushroom used, to an unfavorable medium, or to bacterial contamination.

The first successful pure cultures were made by this method during the early spring of 1902 from mushrooms grown indoors. During the following summer, or as other fleshy fungi appeared in the open, cultures were made from other forms in order to determine the general applicability of the method. The experiments were successful in most cases, although it was found almost impossible to obtain certain species of fungi in a condition young enough to be free from bacterial infestation. In general, the method seemed to commend itself strongly as a means of procuring

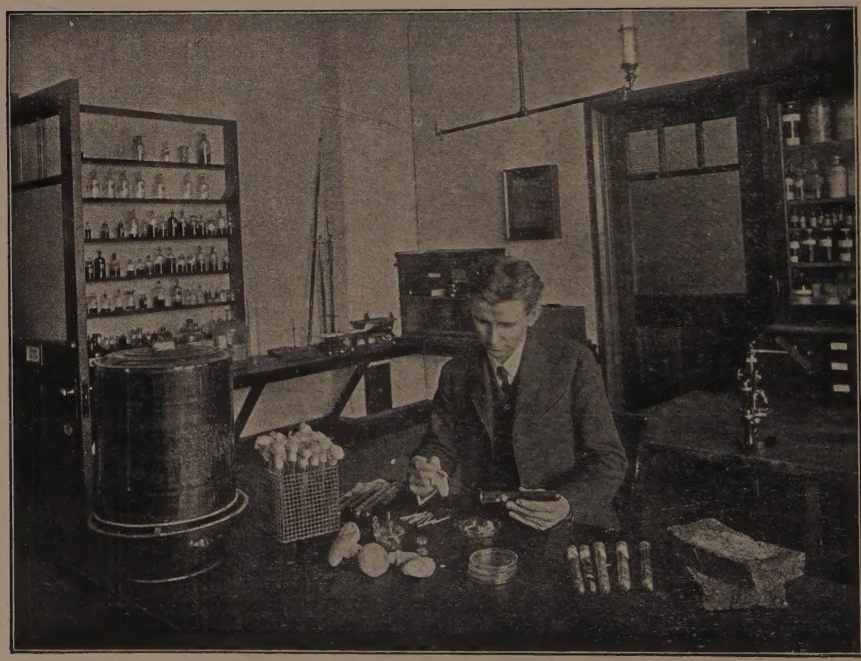

Fig. 207. The Method of Making Pure Cultures, Showing the Apparatus and Materials. From Bulletin No. 85, B. M. Duggar, Bureau of Plant Industry, U. S. Department of Agriculture.

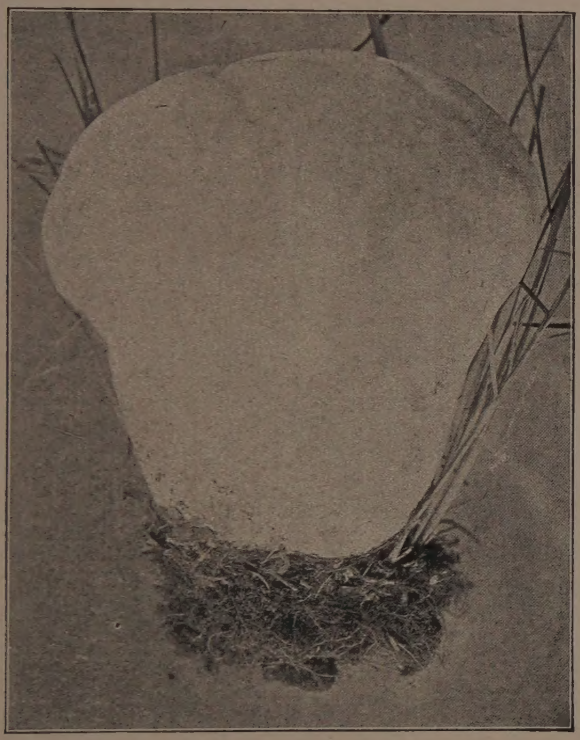

Fig. 208. A Young Specimen of the Common Puffball (CALVATIA CRANIFORMIS). From Bulletin No. 85, B. M. Duggar, Bureau of Plant Industry, U. S. Department of Agriculture.

pure cultures of desirable edible species, particularly of those species the spores of which could not be obtained pure or which could not be readily germinated.

During the two subsequent seasons this method has been employed with a great variety of fungi representing many natural orders. No systematic endeavor has been made to determine the limitations of the tissue-culture method as applied to Basidiomycetes, but, incidental to the general studies, cultures have been made from forms differing very widely, not only in relationship but also in texture and in habitat.

TEMPERATURE AND MOISTURE.—The temperature factor is, next to that of good spawn, perhaps the most important in mushroom growing. It has been frequently stated that mushroom growing is not profitable when the temperature may not be maintained more or less continuously at from 50° to 60° F. It is very probable that the exact temperature which may be considered an optimum will vary somewhat in different sections of the country. It will be noted later in detail that the temperature factor acts not so directly upon the growth of the spawn or the production of mushrooms as indirectly to render some other conditions of the environment injurious. It is best to consider that in practice the optimum temperature for mushroom growing varies from 53° to 58° F.

VARIABILITY IN MUSHROOMS GROWN UNDER DIFFERENT CONDITIONS.—

The writer does not intend to discuss even in a general way the relationships of the various forms of Agaricus—that is, those that may be considered allies of *A. campestris*—which he has cultivated or studied in the field. Some reference to the variability of common forms should, however, be made. For a comprehensive study of species and varieties, a knowledge of European forms as well as of those found in America is essential. Authors differ so widely in their descriptions of species, as well as in their conceptions of them, perhaps, that in the absence of unlimited material nothing short of confusion results from any attempt to harmonize opinions. It is sufficiently difficult to separate what many would regard as varieties of *A. campestris* from those of *A. arvensis.* When specific rank is bestowed also upon such forms as *A. pratensis, A. villaticus, A. magnificus, A. rodmani,* etc., the difficulties are greatly increased. The writer has grown many forms of Agaricus, and, as might be expected, there seems to be no form which will remain practically constant under variable conditions.

Fig. 209. The Oyster Mushroom (PLEUROTUS OSTREATUS), Growing on Decayed Willow Log. From Bulletin No. 85, B. M. Duggar, Bureau of Plant Industry, U. S. Department of Agriculture.

[It might be added that stimulated by Dr. Duggar's work, several firms have undertaken to furnish spawn prepared under conditions that would seem to guarantee success—yielding desirable "varieties" of Mushrooms. Tests by various amateurs and others show that the claims made by these firms can at least sometimes be verified.—Editor.]

Fig. 210. A Fine Bed of Mushrooms Grown from Spawn of Pure-Culture Origin. By D. Duggar, U. S. Dept. Agr.

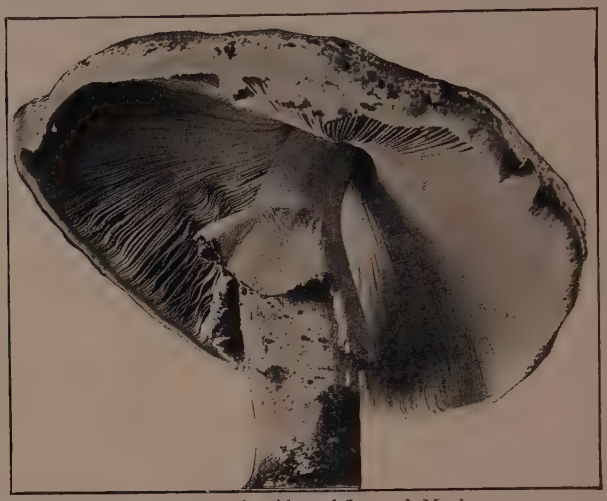

Fig. 211. AGARICUS FABACEUS, the Almond-flavored Mushroom.

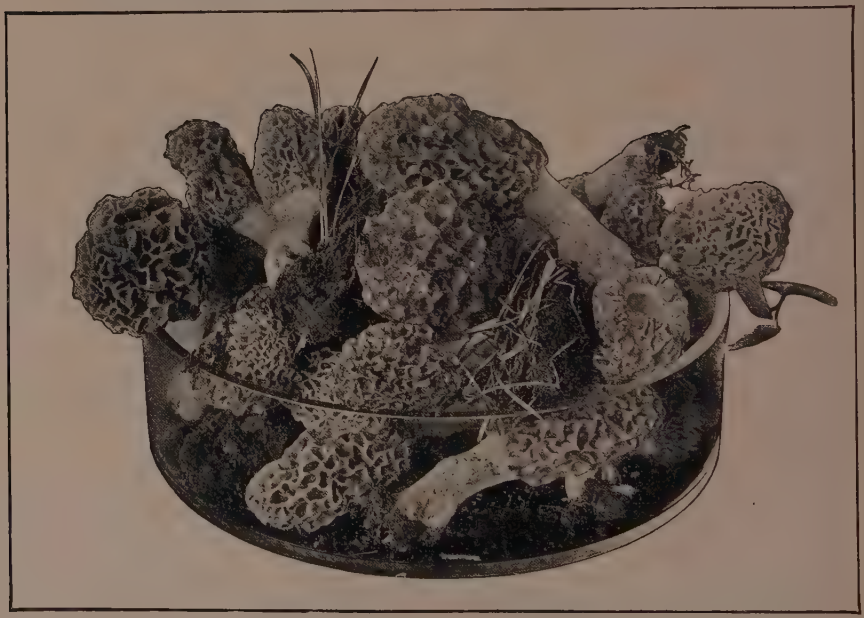

Fig. 212. Morels (MORCHELLA ESCULENTA), One of the Finest Edible Fungi. Cuts furnished by U. S. Dept. Agr. from Bulletin by B. M Duggar.

The Mycological Bulletin is issued Monthly, Price 25c. Copies of Vol. II (1904) and Vol III (1905) may be had for 50 cents each, or cloth bound copies for 75 cents. No. copies remain of Vol. I (1902). Address W. A. Kellerman, Columbus, Ohio

THIS SPACE TO LET